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Hagel et al.

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(54) **FASTENER WITH HARDENED THREADS**

(75) Inventors: **Gerald W. Hagel**, Lombard, IL (US); **Joel Houck**, Lansing, IL (US)

(73) Assignee: **Simpson Strong-Tie Company, Inc.**, Pleasanton, CA (US)

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(22) Filed: **Nov. 18, 2010**

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Related U.S. Application Data

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(51) **Int. Cl.**
F16B 35/00 (2006.01)
F16B 35/04 (2006.01)

(52) **U.S. Cl.**
USPC **411/383**; 411/411; 411/426

(58) **Field of Classification Search**
USPC 411/378, 383, 411, 412, 426, 900–901, 411/424, 438
See application file for complete search history.

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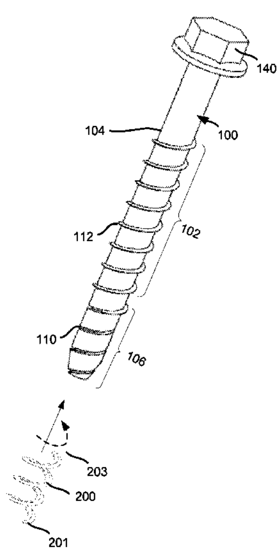
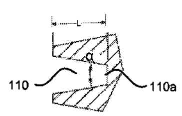
Primary Examiner — Victor Batson
Assistant Examiner — Tyler Johnson
(74) *Attorney, Agent, or Firm* — Vierra Magen Marcus LLP

(57) **ABSTRACT**

A threaded fastener includes a shank having a first, threaded portion and a hardened thread portion. The shank includes a thread extending outwardly from a shank body over a first length of the shank. A second portion of the shank includes a groove positioned coincident with the thread and including a turn ratio equal to a turn ratio of the thread. The shank comprises corrosive resistant stainless steel. A coil of hardened steel engages the groove to fill the groove along the second portion.

15 Claims, 4 Drawing Sheets





SECTION B-B
OF FIG. 2

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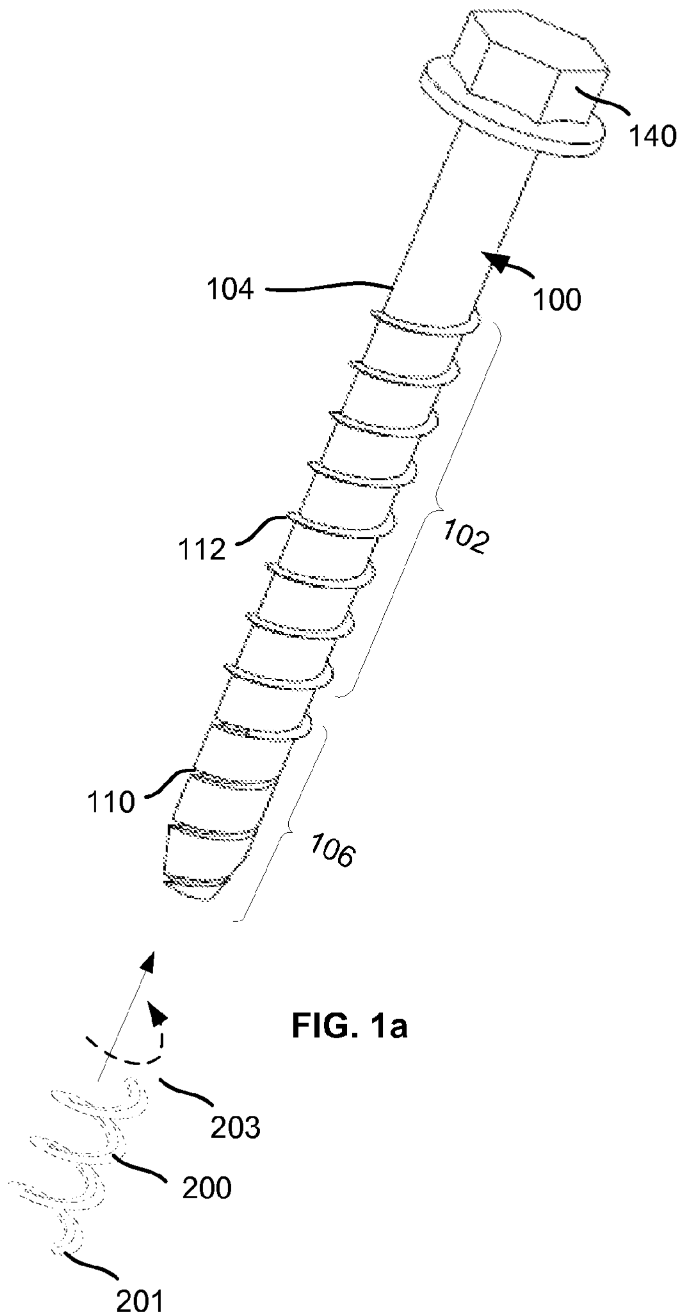
140
104
100
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201

FIG. 1a

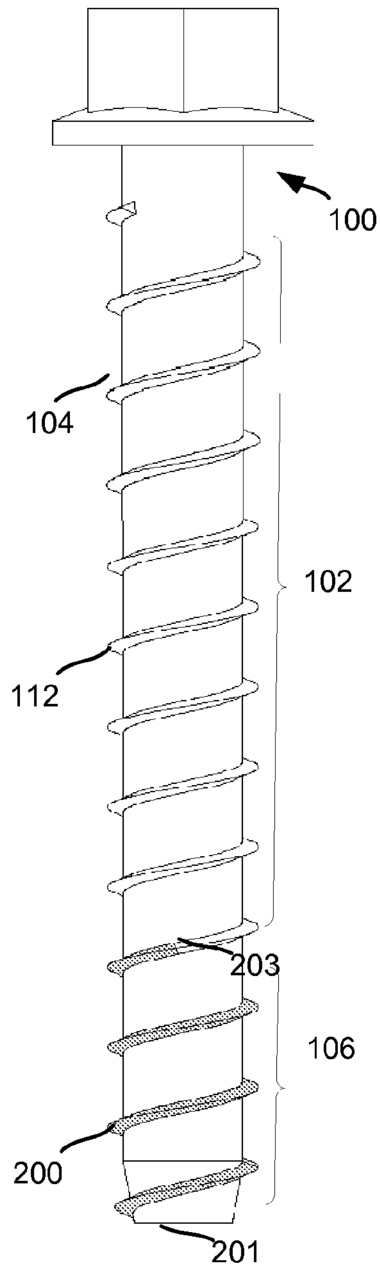
100
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FIG. 1B

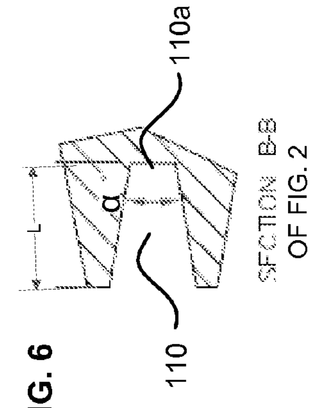


FIG. 6

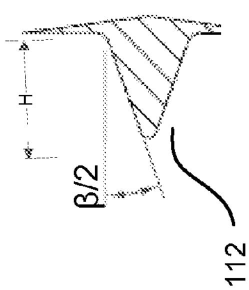


FIG. 5

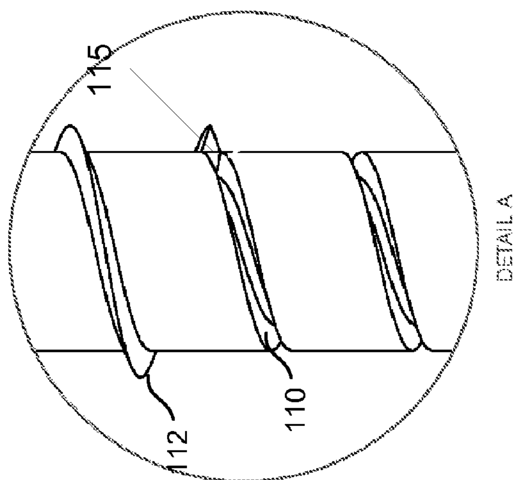


FIG. 3

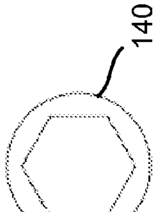


FIG. 4

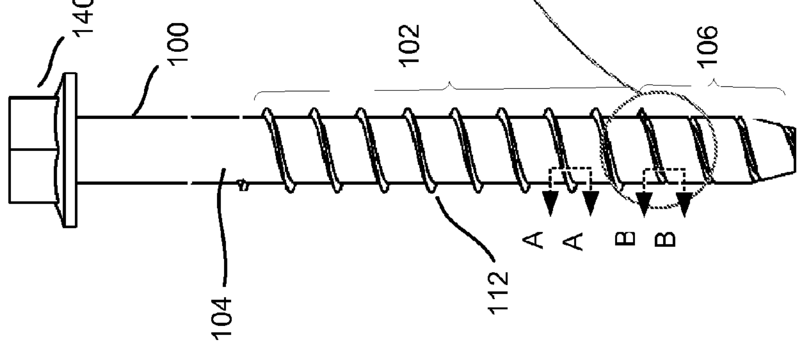


FIG. 2

FIG. 8

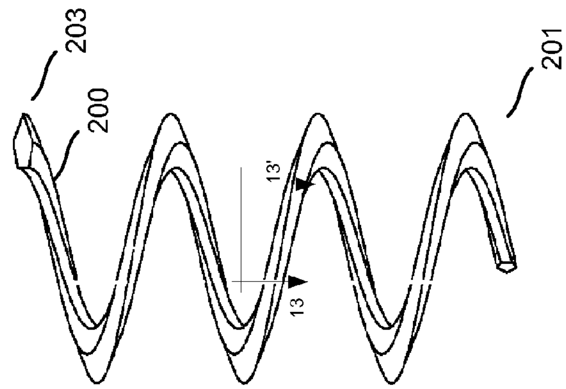


FIG. 9

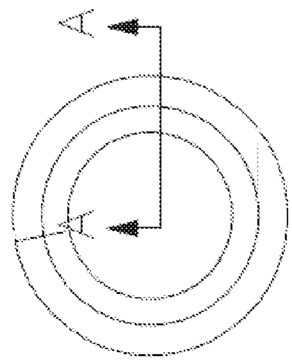


FIG. 7

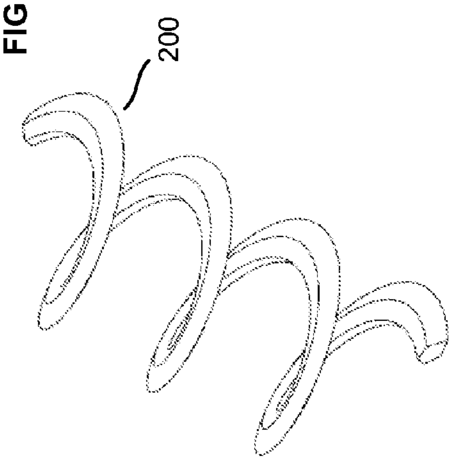
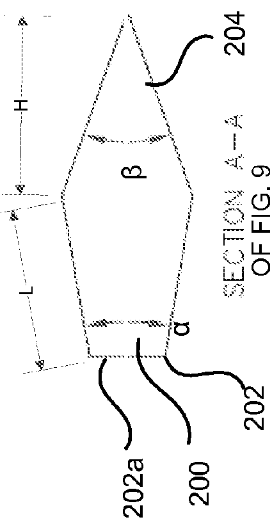


FIG. 10



SECTION A—A OF FIG. 9

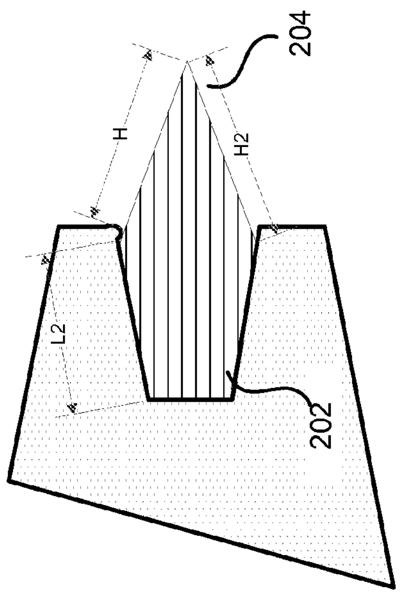


FIG. 12

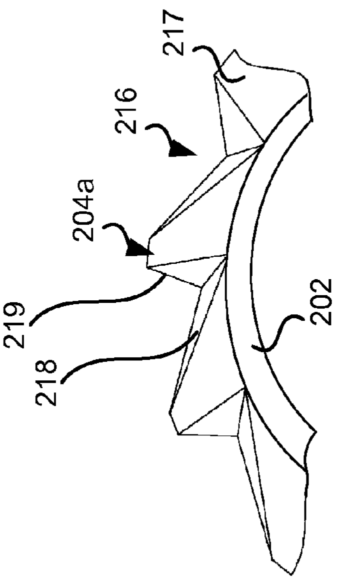


FIG. 13

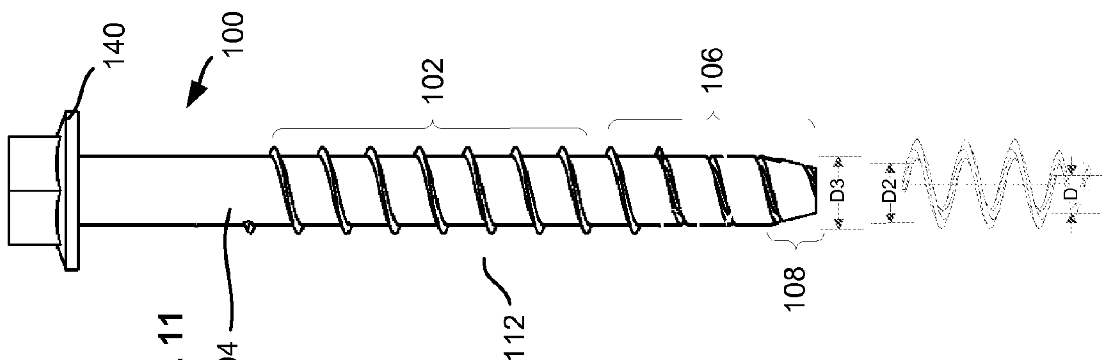


FIG. 11

FASTENER WITH HARDENED THREADS

This application claims the benefit of U.S. Provisional Application Ser. No. 61/262,455, entitled COIL FASTENER, inventors Gerald W. Nagel and Joel Houck, filed Nov. 18, 2009.

BACKGROUND

A variety of fasteners can be used for anchoring structures in concrete or masonry. Self tapping anchors are generally formed of heat-hardened carbon steel.

Stainless steel provides good resistance to corrosion, but lacks the hardness required for self-tapping, heavy duty concrete fastener applications. Typically, such heavy duty fasteners require a very high hardness. A main challenge in using stainless steel for such applications involves the need to harden the tip of the fastener to a very high hardness in order to tap into the concrete.

Although 400 series stainless is capable of heat treatment and hardening, once heat treated, 400 series stainless loses a great deal of its corrosion resistant properties. In contrast, 300 series stainless has the corrosion resistance, however cannot effectively be heat treated to create the self tapping portion of the fastener.

One known solution is to create a bi-metal fastener, by welding or otherwise joining a carbon steel tip to the stainless body. This bi-metal part is then threaded and the carbon steel tip subsequently hardened. A bi metal solution is very expensive due to the number of manufacturing steps that are required.

SUMMARY

The technology, briefly described, comprises a fastener with hardened threads and a method for manufacturing the fastener. The fastener is provided with hardened threads over only a portion of the fastener shank, at a leading edge of the shank. The hardened threads are used for creating cuts in the bore while the balance of the threads are formed of the same material as the fastener itself.

A method for making the fastener is provided. A shank having a threaded portion and a portion including a groove is formed. The shank is formed of a highly corrosion resistant material. A coil thread formed of hardened material is attached to the shank in the groove. The coil thread may be hardened prior to attachment or after insertion into the groove, and may be secured in the groove by a number of techniques.

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a perspective view of a fastener shank and coil positioned for attachment on the shank.

FIG. **1**B is a perspective view of a fastener shank with coil attached.

FIG. **2** is a plan view of the fastener shank shown in FIG. **1**.

FIG. **3** is an enlarged view of a portion of the fastener shank shown in FIG. **2**

FIG. **4** is a top view of the fastener shank

FIG. **5** is a cross-section view along line A-A in FIG. **2**.

FIG. **6** is a cross section view along line B-B in FIG. **2**.

FIG. **7** is a perspective view of a coil having a cross section and shape configured to engage the shank shown in FIGS. **1-6**.

FIG. **8** is a plan view of the coil.

FIG. **9** is a top view of the coil.

FIG. **10** is a cross-sectional view along line A-A in FIG. **9**.

FIG. **11** is a plan view of a second embodiment of a fastener in accordance with the present technology.

FIG. **12** is a partial cut-away sectional view of an assembled coil section mechanically secured in a groove.

FIG. **13** is a partial, cross sectional view of the thread section along line **13-13** in FIG. **8**.

DETAILED DESCRIPTION

A fastener with hardened threads and a method for manufacturing the fastener are provided. In one embodiment, the fastener is provided with hardened threads over only a portion of the fastener shank, at a leading edge of the shank. The hardened threads are used for creating cuts in the bore while the balance of the threads are formed of the same material as the fastener itself. This allows the fastener to be manufactured from corrosive resistant material, while the less corrosively resistant hardened material is kept to a minimum.

In another aspect, a method for making the fastener is provided. A shank having a threaded portion and a portion including a groove is formed. The shank is formed of a highly corrosion resistant material. A coil thread formed of hardened material is attached to the shank in the groove. The coil thread may be hardened prior to attachment or after insertion into the groove, and may be secured in the groove by a number of techniques.

FIGS. **1-10** present a first embodiment of a stainless steel fastener with a hardened thread portion suitable for use in concrete anchoring applications. The anchor generally comprises corrosion resistant material such as stainless steel, and a coil **200** formed in a profile which is identical to a thread profile formed in a shank **100** of a fastener. Typically, the coil **200** is formed of a material which is harder than the shank. In one embodiment, the material is a hardened metal, such as a carbon steel. Typically hardened metals are less corrosion resistant than stainless steel, but are harder and better able to penetrate concrete or other material used with the fastener. Coil **200** may be formed of other materials having a hardness superior to the stainless steel shank.

FIGS. **1**A and **1**B illustrate a perspective and plan view of an unassembled and assembled fastener **100**, respectively. A corrosion resistant shank **104** is formed to include a first portion **102** illustrated in FIGS. **1**A, **1**B and **2** having a coiled, continuous thread **112** with a plurality of turns about and extending from the body **104** of the shank. The shank may have a head **140** at one end of the first portion. In alternative embodiments, any number of different types of securing ends may be provided in place of head **140**. The shank may be formed using thread forming and thread rolling techniques wherein threads and grooves are formed into a blank by pressing a shaped die against the blank

As illustrated in the Figures, a rolled thread **112** is formed on the first portion of the fastener while a groove or channel **110** is formed on the second portion of the fastener shank. As shown in FIG. **3**, the channel portion and the thread portion meet at the intersection **115** of the first and second sections of the shank **100**. The thread **112** and the channel **110** may have the same turn profile. In one embodiment, the shank **104** is formed out of series 300 stainless steel, such as type 316 or 304 stainless steel, to obtain the corrosive resistance properties of the steel. It should be recognized that other suitable corrosion resistant materials may be used. The profile of the thread **112** are illustrated in FIG. **5**

The second portion **106** of the shank include channel **110** so that a coil **200** can be inserted therein to form fastener **100**. The channel profile is illustrated in cross-section in FIG. **6**. The coil **200** is illustrated in FIGS. **7-10**. The coil **200** will be inserted into the channel and secured to the shank **100** by any number of techniques.

Coil **200** is formed to include a number of turns sufficient to allow the coil to be inserted into channel **110** from the intersection **115** to the end of the shank **104**. When inserted into the groove, coil **200** forms a single continuous thread from a first end of the coil **201** to a second end **203**, with thread **112** extending from a point near the first end of the shank to a second end at head **140**. The number of turns provided in the first portion **102** and second portion **106** of the shank can vary such that the number of turns of channel (and a corresponding coil for such channel) in the second portion may be less than, equal to or greater than the number of turns in the first portion.

Coil **200** has a thread section **204** and a base section **202**. The base section has a profile (illustrated in FIG. **10**) which mates with the profile of the channel **110**, illustrated in FIG. **6**. Base section **202** may be formed in a generally trapezoidal shape, with the sides of the trapezoid having a total included angle alpha which, in one embodiment may be 20 degrees, and vary over a range of 0-60°. Channel **110** is formed with a mating profile to receive portion **202**. Channel **110** has a depth L similar to the length of the base section **202**. Coil thread section **204** may be formed of a generally triangular shape having a total included angle beta of 40 degrees. Beta may vary over a range of 40-60°. As illustrated in FIG. **5**, the total included angle of a thread **112** is the same as thread section **204**. Each thread **112** has a height H which is equivalent to the height H of section **204**.

In one embodiment, the coil is attached to the shank before a hardening process takes place. In another embodiment, the coil is hardened prior to attaching the coil to the shank.

Where hardening occurs prior to attaching the coil to the shank, a low-temperature attachment scheme is used. For example, the coil may be secured by a mechanical attachment, such rolling an edge of the groove over a portion of the coil along the length of the coil, a cross-section of which is illustrated in FIG. **12**. Alternatively, the coil may be secured in the groove by an adhesive, soldering or another low temperature process. Any suitable hardening process may be used.

Where a hardening process is used after securing the coil to the shank, a fastening process such as spot, MIG or other welding of the coil **200** in place may be used. Alternative attachment processes include resistance welding and high temperature soldering. Hardening after securing the coil to the shank may take place through use of an induction hardening process, wherein the coil **200** is heated by induction heating and then quenched or allowed to cool.

As illustrated in FIG. **10**, a cross-section of the coil **200**, the inner portion of the coil has a profile similar to that of the channel or groove **110**. This allows the channel coil fit securely into the channel.

This fastener solution means that the only portion of the stainless fastener that will require heat treating is the coil, which will result in a tremendous cost savings.

The coil portion is made from hardened, heat treated carbon steel, or any alternate material (metal or non-metal) having a hardness superior to that of the shank. When joined to the shank **100**, the coil acts to create the threads into the concrete, leading the thread **112** attached to the body into concrete.

The hardened coil **200** will actually create the threads in concrete; however, anchor loads are supported by the balance of the shank and threads **112**. For load bearing purposes, load support can ignore the front end of the screw where the coil is located, and support for the entire capacity of the anchor may be based on first end **102** of the screw.

FIG. **11** illustrates another embodiment of the fastener. Shank **104** includes a leading edge section **108** having a taper with a smaller diameter toward the leading end of the fastener **100**. As illustrated in FIG. **11**, the shank **104** has a diameter D3 defined by the surface of the shank. The base **110***a* (FIG. **6**) of the channel defines a second diameter D**2**, corresponding to the inner diameter of the coil **200** defined by edge **202***a* of base portion **202**. In one embodiment, shank **104** includes a region **108** having a decreasing diameter, and the leading end of the coil has a diameter D, smaller than the diameter D**2** of the channel in the second portion **106** outside of region **108**, to match the diameter D defined by base **110***a* in region **108**.

It should be understood that the amount taper provided of this leading end section **108**, and the corresponding reduction in the diameter of the coil, may vary in a number of ways, including length, taper and number of turns provided in the leading edge section **108**.

FIG. **12** illustrates another embodiment of the fastener wherein the coil section **204** is manufactured with a slightly longer thread section of length H**2** greater than H, and channel formed to depth L**2** greater than L. This allows the coil **200** to be seated lower in the channel **110** and an edge **250** of the channel rolled on the coil along the entire length of turns of the coil, or swaged at discrete points along the length of the coil, to secure the coil in the channel **110**. Note that the height H of the thread section extending above the surface of the shank remains at H—equivalent to the height of the thread **112** in the first section of the shank.

FIG. **13** shows an additional variation on the present technology wherein the thread section **204***a* of the coil **200** is interrupted at intervals by recesses **216** to form cutting teeth **217** with a cutting edge **217***a* directed in the screw-in direction of the screw. FIG. **13** is a cross sectional view of the thread section **204***a* along line **13-13"** in FIG. **8**. The pitch of the cutting teeth is chosen, for instance, such that from six to thirty teeth per turn will result, depending on the diameter. The recesses **216** which interrupt the thread **204***a* are designed so that a planar surface **218** will be formed at the root of the recess, and cutting flanks **219** define the teeth **217**. The teeth **217** may be formed along the entire length of the coil between the first end **201** and the second end **203**, or may be formed over only a part of the coil length at, for example the first or leading end **201**.

The embodiment of FIG. **13** may be formed in accordance with the teachings of U.S. Pat. No. 5,674,035, hereby fully incorporated by reference.

The technology has advantages over fasteners having an end portion of hardened, less corrosive material joined to the end of a shank. With welded, hardened tip fasteners, the less corrosion resistant tip will eventually corrode, and the corrosion product can expand to several times the volume of the original tip, creating a large amount of pressure in the concrete. Hence, a fastener with the welded tip cannot be used close to the edge of a concrete slab because the pressure will overcome the strength of the concrete and cause a breakout of the edge resulting in a loss of holding capacity. With the instant technology, the volume of less corrosion resistant material is much smaller, so there is little to no pressure created by the expanding corrosion product.

Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

What is claimed is:

1. A fastener comprising:

a shank formed from a corrosion resistant material having a threaded portion including a thread extending outwardly from the shank and formed from the corrosion resistant material, and a second portion including a groove formed in the second portion, the groove having a trapezoidal cross-sectional profile;

a thread component comprised of a material having a greater hardness than the shank and engaging the second portion of the shank by mating with the groove.

2. The fastener of claim **1** wherein the corrosion resistant material comprises a series 300 stainless steel and the thread component comprises carbon steel.

3. The fastener of claim **1** wherein the thread component includes a base having a trapezoidal cross-section which engages the groove formed in the second portion of the shank and mates with the threaded portion such that a continuous thread runs from a first end of the shank to a second end of the shank.

4. The fastener of claim **1** wherein the thread component comprises hardened carbon steel prior to engaging the shank.

5. The fastener of claim **1** wherein the thread component is hardened after engaging the shank.

6. The fastener of claim **1** wherein the thread component is mechanically secured in a groove in the second portion of the shank.

7. The fastener of claim **1** wherein the thread component is welded to the shank.

8. The fastener of claim **1** wherein the shank includes a tapered leading edge and the thread component comprises a coil mounted in a groove formed in the second portion, the coil including a diameter matching a diameter of the groove formed in the second portion and the tapered edge.

9. A threaded fastener comprising:

a shank having a first, threaded portion including a thread extending outwardly from a shank body over a first length of the shank, and a second portion having a groove abutting and continuing the thread and including a turn ratio equal to a turn ratio of the threaded portion, the shank comprising corrosive resistant stainless steel, the groove including a trapezoidal cross-sectional profile; and

a coil engaging the groove to fill the groove along the second portion, the coil comprising hardened steel.

10. The fastener of claim **9** wherein the coil includes a base having a trapezoidal cross-section which engages the groove matching the thread such that the coil and thread form a continuous thread from a first end of the shank to a second end of the shank.

11. The fastener of claim **10** wherein the coil comprises hardened carbon steel prior to engaging the shank.

12. The fastener of claim **10** wherein the coil is hardened after engaging the shank.

13. The fastener of claim **10** wherein the coil is mechanically secured in a groove in the second portion of the shank.

14. The fastener of claim **10** wherein the coil is welded to the shank.

15. The fastener of claim **10** wherein the shank includes a tapered leading edge and the coil includes a diameter matching a diameter of the groove formed in the second portion and the tapered edge.

* * * * *